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FORMULA-FEED WAREHOUSING COSTS

A Study in Improving Efficiency in Marketing of Farm Feeds

Agricultural Marketing Service
Marketing Research Division
U. S. DEPARTMENT OF AGRICULTURE

PREFACE

This publication reports on the second phase of a study of the costs of operating formula-feed warehouses. The U. S. Department of Agriculture is conducting this research to determine ways of increasing operational efficiency, thus reducing marketing costs. The study is part of a national program of research aimed at improving the marketing of farm products.

The first phase of this study was reported in "Case Study of Labor Costs and Efficiencies in Warehousing Formula Feeds," Marketing Research Report No. 205, issued by the Department in November 1957.

This study was made by Richard Muther and Associates, Consultants in Industrial Management, Kansas City, Mo., under contract with the Department. This contractor also made time and motion studies under a separate contract with the Midwest Feed Manufacturers' Association, composed of numerous feed manufacturers in the Midwest. Data were made available by the association for the present analyses. The Midwest Feed Production School Committee of the association assisted in planning and organizing the study.

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FORMULA-FEED WAREHOUSING COSTS
A Study in Improving Efficiency in Marketing of Farm Feeds

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HIGHLIGHTS

Calculated labor costs in a model warehouse for formula feeds, compared with actual costs in six representative warehouses, indicate the possibility of reducing these labor costs to the industry by approximately one-third. These savings appear to be the result of improved warehouse design, better location of feed items, and some influence of an increased rate of flow of bags of feed.

The importance of interior remodeling and of analysis of item location is apparent, since the time used in transporting feeds was reduced relatively more than manual-handling time.

The model warehouse design was developed in a research project by the Agricultural Marketing Service, U. S. Department of Agriculture, in cooperation with the feed industry.

INTRODUCTION

Previous studies of the formula-feed industry have analyzed average operating costs 1/ and established labor standards 2/ for the services and operations performed, on a per-ton basis. Comparisons of the labor costs and labor standards not only indicated that the warehousing operation accounted for about one-third of the industry's labor costs, but also that relatively large labor savings could be achieved in this operation (table 1).

The Midwest Feed Manufacturers' Association, through its Feed Production School Committee, and the U. S. Department of Agriculture decided to make a coordinated study of warehousing of formula feeds. In this study, 2 separate phases were developed, 1 by the association and 1 by the Department. The Department's study was designed to (1) analyze labor use, including both work and delay time, in 3 types of warehousing operations, namely, by hand truck,

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1/ Brensike, V. J., and Askew, W. R., Costs of Operating Selected Feed Mills, Mktg. Res. Rept. No. 79, U. S. Dept. Agr., Washington, D. C. February 1955.

2/ Midwest Feed Manufacturers' Association, In-plant Cost Standards, Proceedings 1956 Feed Production School, Kansas City, Mo.

Table 1.--Production man-hours required per ton of formula feed produced in plants with different volumes, by cost centers, 1956

Cost Centers	7,500 to 10,000 tons per year			25,000 to 35,000 tons per year			50,000 to 75,000 tons per year		
	Industry average 1/	Better-than-average plants 2/	Cost standards developed by industry 3/	Industry average 1/	Better-than-average plants 2/	Cost standards developed by industry 3/	Industry average 1/	Better-than-average plants 2/	Cost standards developed by industry 3/
	Man-hours	Man-hours	Man-hours	Man-hours	Man-hours	Man-hours	Man-hours	Man-hours	Man-hours
Ingredient receiving	.352	.275	.162	.230	.154	.080	.154	.143	.071
Grain processing	.128	.100	.038	.105	.070	.019	.056	.052	.008
Mixing	.608	.475	.341	.357	.238	.145	.238	.221	.122
Pelleting	.160	.125	.119	.126	.084	.075	.084	.078	.046
Packing	.480	.375	.175	.336	.224	.109	.210	.195	.087
Warehousing	1.216	.950	.671	.735	.490	.309	.490	.455	.264
Maintenance	.256	.200	.160	.210	.140	.150	.168	.156	.126
Foreman	4/	4/	.133	4/	4/	.080	4/	4/	.080
Total	3.200	2.500	1.799	2.100	1.400	0.967	1.400	1.300	0.804

1/ Marketing Research Report No. 79, brought up to date by Census trends in production labor efficiency. Breakdown estimated from the better-than-average plants.

2/ Analysis of basic data purchased from the Midwest Feed Manufacturers' Association from 1956 study.

3/ 1956 Proceedings of the Midwest Feed Production School.

4/ Included in the relevant cost center.

lift truck, and belt conveyor; and (2) design and reconstruct operating practices in a model mill, for use as a standard of comparison for operating warehouses.

Findings concerning the first objective of the Department's study already have been reported. 3/ This report indicated that manual handling operations consume about 45 percent of the average worker's time; transport, about 26 percent; and idle or delay time, 29 percent. More than three-fourths of the idle or delay time resulted from occurrences beyond the control of the worker; such delay time included waiting for a car or truck, waiting for a changeover, idle time due to intermittent work flow, and waiting for a previous operation. Each of these categories is under the control of management. The report also indicated that in a 100-ton-per-day operation, warehouses using forklift trucks had a smaller proportion of delay time than did the other types, and also they could, under existing operating conditions, handle a larger tonnage per man-hour.

A detailed time and motion analysis of the warehouse work time was made in the association's study. In this analysis, each operation was broken into the individual motions involved and was either timed or measured in terms of standard motion data.

Objectives

The objectives of this study were to determine the **worktime** required to operate the warehousing phases of a theoretical or model mill, and, by using these results as a standard, to determine the influence of mill design and item location on the operating efficiency of mills included in the study.

This model mill can be used as a tool of management in analyzing the efficiency of warehouses and in determining the probable savings if a new or redesigned warehouse were built or more emphasis were placed upon planning the location of items in the warehouse.

Methodology

Both of these studies were conducted under contract by the same contractor in the same 6 representative mills of which case studies were made. Two of the warehouses were operated with 2-wheel hand trucks, and 2 with forklift trucks; the other 2 were basically conveyor-belt operations, although, since 40 to 50 percent of the feed was moved into the warehouse for storage before shipping, some other method had to be used in addition to movement by conveyor.

3/ Askew, W. R., Vosloh, C. J., and Brensike, V. J., Case Study of Labor Costs and Efficiencies in Warehousing Formula Feeds, Mktg. Res. Rept. No. 205, U. S. Dept. Agr., Washington, D. C., November 1957.

Each of these warehouses was chosen by industry people as representative of its particular type of operation. The contractor visited about 25 of these representative warehouses, located within 200 miles of Kansas City, Mo., to determine those which were most representative and willing to cooperate. The universe from which the industry association was determining representativeness was its own members and enrollees in the previous Production Schools. Thus, it is probable that these plants represent better-than-average warehouse operations when the entire industry is considered (table 1).

Each of these warehouses handled approximately 100 tons of mixed feed per 8-hour day of operation. An earlier study had indicated that costs in the industry tend to level out considerably after a volume between 20 and 30 thousand tons of mixed feed per year is reached. Each warehouse was studied on a Tuesday, Wednesday, and Thursday in June, July, or August, 1957.

Reliability of time sample

The work sampling observations made in each mill were taken at random times throughout each of the prescribed 8-hour working days. Observations were taken instantaneously from prescribed areas of the warehouse. The travel route from observation point to observation point was altered frequently to minimize any anticipation by the workers. Observations were made for an average of about 6 workers during each trip through the warehouse. Thus, a total of 1,200 observations were taken for each type of warehouse, or 600 in each individual warehouse. It is believed that similar types of warehouses can be combined and the total observations considered, since the 600 observations in each of the hand-truck warehouses resulted in nearly identical information. The same is true for the observations in each of the forklift warehouses. Only in the 2 conveyor warehouses did any significant differences occur in some of the work categories. These differences arose because hand-trucks were used to supplement the conveyor belt in one plant, while forklift trucks were so used in the other.

Combining the observations from similar warehouses, the estimated standard error of each of the work or delay categories, shown in table 2, ranges from ± 1.4 percent for 48.7 percent of the observations to ± 0.3 percent for 0.9 percent of the observations. If individual warehouses are considered separately, the estimated standard errors of these proportions become ± 2.0 percent and ± 0.4 percent, respectively.

Model Warehouse

A model warehouse design, drafted on the basis of earlier studies, was further refined as a result of the time and motion analysis (fig. 1). It represents not an ideal warehouse design, but rather a sound arrangement based upon current practices. Specifications which this model warehouse is designed to meet are:

1. Mill capacity, 100 tons per 8 hours.

Table 2.--Estimated proportion of a warehouse worker's time spent in specific types of work and delay

Operation	Forklift		Hand truck		Conveyor belt	
	Percentage of total observations	Estimated standard error of proportion 1/	Percentage of total observations	Estimated standard error of proportion 1/	Percentage of total observations	Estimated standard error of proportion 1/
	Percent		Percent		Percent	
Manual handling	48.7	.014	39.2	.014	46.9	.014
Load	14.8	.010	21.1	.012	9.5	.008
Unload	17.6	.011	9.7	.009	14.5	.010
Prepare, close car, and check	5.2	.006	3.4	.005	5.8	.007
Handle ingredients	2.8	.005	0.9	.003	4.0	.006
Cleanup and other work	8.3	.008	4.1	.006	13.1	.010
Transport	26.1	.013	33.9	.014	17.2	.011
Direct to transport	2.4	.004	5.9	.007	0	
To warehouse	3.2	.005	10.2	.009	2.8	.005
Warehouse to transport	9.3	.008	7.3	.008	6.8	.007
Relocate in warehouse	1.7	.004	0		2.6	.005
Transport empty	9.5	.008	10.5	.009	5.0	.006
Idleness and delay	25.2	.013	26.9	.013	35.9	.014
Outside worker's control	18.2	.011	22.1	.012	25.3	.013
Within worker's control	7.0	.007	4.8	.006	10.6	.009
Total	100		100		100	

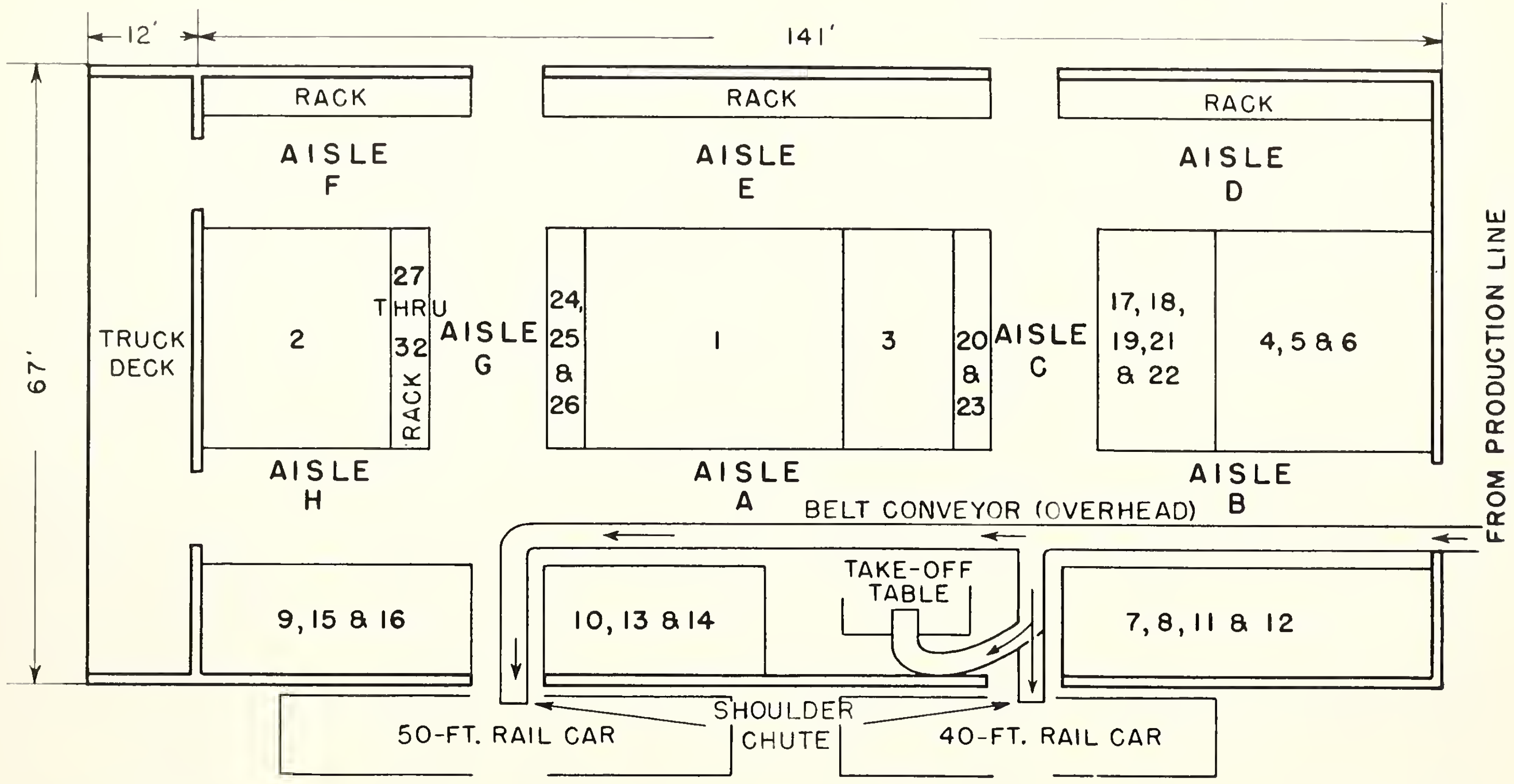
1/ The percentage of total observations plus or minus these standard errors results in a range within which, in 2 chances out of 3, the true meaning will be found.

MODEL WAREHOUSE LAYOUT

Total Area 9,450 Sq. Ft.

Maximum Capacity 780 Tons

Capacity at 70 % = 546 Tons



The numbers 1-32 represent the number of items handled in the warehouse in order of rank, with the largest selling item as number 1. The remaining 50 slow-moving items will be stored in the racks to facilitate partial pallet handling.

U. S. Department of Agriculture

Neg. 6114-58 (4) Agricultural Marketing Service

Figure 1

2. Warehouse to hold 5-day supply of feed (500 tons) at approximately 70 percent of warehouse space utilization.

3. Movement of feed as follows:

    a. 75 tons from the takeoff belt or table into warehouse storage.

    b. 25 tons directly from the takeoff facility into railroad cars.

    c. 50 tons from warehouse storage to road trucks for shipment.

    d. 25 tons from warehouse storage to railroad cars for shipment.

4. Feed produced and stored is made up in the following manner:

    a. Total number of formulas manufactured, 80.

    b. Bag sizes and quantities:

        5 percent of total feed packed in 25-pound bags.

        75 percent of total feed packed in 50-pound bags.

        20 percent of total feed packed in 100-pound bags.

    c. Several feeds are manufactured in different forms, such as mash, pellets, and crumbles. When the different forms are considered, the 80 formulas become 100 different types of feeds.

        Some feeds are packed in more than 1 size of bag, making the number of different items -- that is, different bag sizes and different forms -- a total of 130 items or varieties.

5. Aisles 12 feet wide.

6. Add 25 percent to forklift times for partial pallets, double handling, etc.

7. 750 bags are transferred from 1 pallet to another.

Results of the association's time and motion analysis, a sample of which appears in table 3, were then combined into the tasks necessary to operate this model warehouse.

Table 3.--Tables of standard times: Time for handling bags with pallets, 2000 pounds per pallet load

Code	Operation	Bag size in pounds	Man-hours per		Bags per minute
			Bag	Ton	
L1A	Load pallet with loading guide from takeoff table	25	.00074	.0592	22.5
L1B		50	.00085	.0340	19.6
L1C		100-1 man	.00149	.0298	11.2
L2A	Load pallet without loading guide from takeoff table	25	.00078	.0624	21.3
L2B		50	.00089	.0356	18.7
L2C		100-1 man	.00149	.0298	11.2
L3A	Load bag from one pallet to 2nd pallet	25	.00098	.0784	17.0
L3B		50	.00120	.0480	13.9
L3C		100-1 man	.00188	.0376	8.9
L3D		100-2 men	.00193	.0396	17.3
U1A	Unload bag from pallet and stack	25	.00136	.1088	12.3
U1B		50	.00150	.0600	11.1
U1C		100-1 man	.00276	.0552	6.0
U1D		100-2 men	.00170	.0680	9.8

Code	Operation	Unit	Man-hours Per Unit
F1	Travel up to 20 feet per trip	Foot	.00009
F2	Travel from 20 to 50 feet per trip	Foot	.00008
F3	Travel from 50 to 100 feet per trip	Foot	.00006
F4	Travel over 100 feet per trip	Foot	.00005
F5	Turn in, stack in or get from 1st tier and back out	Pallet	.0063
F6	Turn in, stack in or get from 2nd tier and back out	Pallet	.0070
F7	Turn in, stack in or get from 3rd tier and back out	Pallet	.0078
F8	Turn in, stack in or get from 4th tier and back out	Pallet	.0087
F9	Turn in, stack in or get from 5th tier and back out	Pallet	.0096
F10	Turn in, pick up unobstructed pallet and back out	Pallet	.0029
F11	Run in straight, pick up unobstructed pallet and back out	Pallet	.0025
F12	Turn in, deposit pallet in unobstructed location and back out	Pallet	.0025
F13	Run in straight, deposit pallet in unobstructed location and back out	Pallet	.0021
F14	Run into rail car, deposit or obtain pallet and back out	Pallet	.0056
F15	Run into truck, deposit or obtain pallet and back out	Pallet	.0044
F16	Turn in to "take it or leave it load," obtain and back out	Load	.0051
F17	Run straight to "take it or leave it load," obtain and back out	Load	.0047
F18	Run into rail car, deposit "leave it" load and back out	Load	.0070
F19	Get on or off lift truck and go to or from front of pallet	Occurrence	.0020
F20	Obtain and position, or, set aside roll in dolly for pallets--2 men	Occurrence	.0110
F21	Push loaded dolly to 1st tier--2 men	Occurrence	.0053
F22	Push loaded dolly to 2nd tier--2 men	Occurrence	.0065
F23	Push loaded dolly to 3rd tier--2 men	Occurrence	.0076
F24	Push loaded dolly to 4th tier--2 men	Occurrence	.0088
F25	Push empty dolly from 1st tier--2 men	Occurrence	.0036
F26	Push empty dolly from 2nd tier--2 men	Occurrence	.0046
F27	Push empty dolly from 3rd tier-2 men	Occurrence	.0056
F28	Push empty dolly from 4th tier--2 men	Occurrence	.0066

Comparison--Model vs. Actual

The model mill specifications 1, 4, 5, 6, and 7, just described, were based upon the averages found to exist in the 6 case-study mills. The movement of feed (item 3) is almost identical with the actual movement in the 2 forklift warehouses, and the industry tends to have somewhat smaller warehouses than the model mill (item 2). Therefore, a valid comparison can be made between the model operation and the actual operations. This is especially true since the time and motion results were based upon the operations performed by the same men, in the same mills, and during the same time of year as the actual operation. A comparison of this type should result in some indication of the size of the potential labor efficiencies and should indicate that these worktime efficiencies must result primarily from the following: 4/

1. Improving the warehouse design and layout.

2. Decreasing the distance necessary to transfer items to the warehouse and then out by giving more consideration to the frequency of movement, including ease of partial pallet handling.

3. Increasing the rate of flow of bags from the packer. This is a factor even though delays for changeover, intermittent work flow, and wait for previous operation (two-thirds of total idle and delay time) are excluded from the work sampling items appearing in table 4. Only worktime is considered.

Table 4.--Volume handled in bags per unit of worktime 1/

Item	Work sampling study		Model warehouse
	Six-mill average	Forklift average	Three-man status 2/
Tons per man-hour	5.20	5.45	7.28
Man-hour per ton	.201	.185	.137
Man-minutes per ton	12.1	11.1	8.22

1/ Idle and delay times excluded.
2/ Slightly more than required, but it retains full man operations and serves to cover cleanup and related work which is covered in the work sampling data.

It appears that these factors can improve the warehouse worker's efficiency while in a work status about one-third above that found in the study of the 6 representative mills (table 4). Warehouse workers in the 6 mills

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4/ If the errors inherent in each type of study are at a minimum or are assumed to be excluded.

handled about 5.2 tons of bagged feed per man-hour. In the 2 forklift-truck-warehouses, 5.5 tons of feed were handled per man-hour, and in the model mill 7.3 tons of feed could be handled. Even the model warehouse could not operate in many areas and retain the perfect item location assumed because of seasonal shifts in demand. These imperfections, however, were recognized in establishing the 25 percent allowance for partial pallet handling, etc. 5/.

Further analysis of this comparison of model vs. operating labor inputs and tonnage of outputs shows that the model mill increases the efficiency of the transport time much more than it does manual-activity time (table 5). Transportation represented about 35 percent of a worker's time while in work status, either on the basis of the 6 mills studied or in the forklift truck warehouses. In the model mill, transportation requires about 24 percent of the worktime.

Table 5.--Distribution of worktime 1/

Function	Work sampling study: Six-mill average	Work sampling study: Forklift average	Model warehouse
	Percent	Percent	Percent
Manual activities	62.6	64.5	76.5
Transporting	37.4	35.5	23.5
Total	100.0	100.0	100.0

1/ Idle and delay time excluded.

Since many warehouses in this size of feed mill are comparable to or slightly smaller than the model, the relatively greater decrease in travel time indicates the importance of remodeling and an analysis of item location. Most of these potential efficiencies appear to result from changes in these two factors rather than from the basic warehouse size or design. Certain warehouses, of course, have the added problems and further potentials of increasing efficiency which result from a poor or outmoded basic warehouse design or size.

In a problem such as this, remodeling or new construction costs must be considered. If the potential savings shown in this report are all contingent upon building a new warehouse, the savings, valued at $1.50 per hour, will support an investment over a 30-year period of about $67,000 per shift. Even in these warehouses, however, this study indicates that sizable worktime efficiencies may result from minor remodeling and an analysis of item location.

5/ In some plants, a larger allowance may be needed for these problems.

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